

# Autonomous Coex Clover Race Drone Quickstart Guide

## Purpose

Materials and Processes needed to train and prepare the autonomous quadrotor race drone for flight testing.

## Context

Usage of these Standard Operating Procedures (SOPs) ensure that the quadrotor drone is properly checked and ready for flight, as well as ensuring the intended models and code is used to autonomously control the drone mid-flight. All testing must be done indoors or within a drone cage; The drone as-is does not meet FAA regulations for outdoor flight. Because of the use cases of the drone, it does not currently need to be tested outside.

## Definitions

### Telemetry

The data about the aircraft state (height, orientation, global coordinates, etc.).

### Arming

Armed is the state of copter readiness for the flight. Usually, a copter starts rotating its propellers when it is switched to the "armed" state, even if the gas stick is down. The opposite state of armed is "disarmed"

### PX4

A popular open source flight controller software that works with the Pixhawk series of flight controllers, Pixracer, and others. PX4 is recommended to be used with Clover.

### MAVLink

A communication protocol for drones, ground stations and other devices over radio channels. This protocol is widely used for telemetry.

## ROS

The current framework in the drone, used for writing complex robotics applications. Widely popular in the industry.

## IMU

Inertial measurement unit. A set of inertial sensors (a gyroscope and an accelerometer; a magnetometer is typically added as well) that allow the drone to compute its orientation (and, to a lesser extent, position) in space.

## Estimation

A process of current state (position, rotation, velocity, angular rates, etc.) estimation performed by the flight controller software. A [Kalman Filter](#) is typically used for sensor fusion; other filters are typically applied to raw sensor data.

PX4 has two estimation modules: LPE and [ECL EKF](#) (EKF2). Currently in use is LPE.

# Tools and Equipment

## Material

- COEX Clover Drone
- Coex Clover Radio Transmitter
- Vicon Motion Capture System
- Raspberry Pi 4B (RPi)
- Pix Flight Controller (FCU)
- Arducam 100fps Mono Global Shutter USB Camera
- Gemfan Drone racing gates
- XYG- Raspberry Pi R Camera
- Power Distribution Board
- MR30 connector ( for motor speed control)
- SMC 2200mAh 4s 80c High Cycle Life-High Performance LiPo Battery
- LiPo Battery Charger

## Software

- ROS Noetic
- Coex Clover Custom Firmware

## Simulation/Model Acquisition

- Gazebo version 11.15.1
- Python 3.9
- Tensorflow version 2.13.0
- TF-agents version 0.17.0
- Numpy version 1.24.3
- Nvidia CUDA Development Kit 11.8

- Gymnasium version 0.29.1

**Log In Information:**

- Clover Drone Raspberry Pi login info:
  - Username: pi
  - Password: raspberry
- RCPSL Lab Computer Password:
  - rcpsl\_vicon
- Clover-9133 Hotspot
  - cloverwifi

## How To Prepare the Drone for Real-World Testing

1. Ensure battery is at least 50% full before attempting test flight
  - a. If it is not sufficiently charged, [charge it](#).
  - b. Battery type: LiPo
  - c. Number of Cells: 4s
  - d. Amperage Charging Rate: 2.2
2. Physical Drone Inspection
  - a. Ensure all hardware (RPi, FCU, Rangefinder, Downward Facing Camera, LED Ring, Wires, Frame, Battery) are all secure
  - b. Ensure propellers are flight-ready and secure to motors
  - c. Ensure no wires are within propeller rotation path
3. Safety Precautions
  - a. Ensure drone safety net/safety cage is down and secure before flight
  - b. If handling drone directly, equip heavy duty gloves
  - c. If within line of sight of drone, equip safety glasses
  - d. Ensure the code you will run has the safe waypoints for the location you are testing in
4. Pre-power on checks
  - a. Boot up base station (in RCPSL Lab, use Vicon computer if needed)
  - b. Boot up QGroundControl on base station
  - c. Turn on Radio Transmitter and ensure all sticks and switches are down, and dials are fully rotated clockwise (Explained further in *more details* section.
  - d. Place drone in area with open space
5. Power on Drone
  - a. Mount & Secure Battery
  - b. Plug in battery (drone should have a series of beeps and led ring should turn on)
6. Connect to Drone on Basestation
  - a. Connect to wifi hotspot "clover-9133", password: "cloverwifi"
  - b. Connecting to drone telemetry using QGround Control is recommended, although other services which achieve the same thing exist
  - c. Connect to <http://192.168.11.1/> to access the Coex clover drone interface.
7. Either SSH into drone or connect to drone through drone terminal in drone interface
  - a. Enter command "roslaunch clover aruco.launch" on drone to launch aruco marker detection

- b. Enter command “roslaunch clover [selfcheck.py](#)” to ensure all systems are running
- 8. Final Checks
  - a. In Coex Clover drone interface, view image topics and 3d visualization to ensure expected position estimation and camera operation
  - b. QGroundControl should report “ready to fly”
- 9. Manual Flight Check
  - a. On radio transmitter, turn killswitch dial (top left) all the way counter clockwise to turn off killswitch
  - b. On radio transmitter, Turn flight mode dial (top right) all the way counter clockwise to stabilized mode
  - c. Arm drone through QGroundControl software. Drone propellers will begin spinning
- 10. Soft takeoff and landing
  - a. Manually fly drone briefly to ensure flight is possible and stable
  - b. When done, land drone and safely replace drone in a safe location before continuing to automated flight
- 11. Automated Flight
  - a. Before starting script, ensure drone pilot (tester with radio transmitter) is ready to activate killswitch. Killswitch is activated by rotating killswitch dial counterclockwise until a threshold is met.
  - b. Run automated flight script either using python3 or roslaunch
- 12. After drone testing is done
  - a. Ensure killswitch is on and automated scripts are finished before approaching drone
  - b. QGroundControl software should say disarmed or ready to fly, meaning drone is not actively flying
- 13. Disconnect battery from drone
  - a. Ensure battery is at proper storage voltage before storing in LiPo-safe bag
  - b. Turn off radio transmitter
- 14. Turn off base station
  - a. Put away equipment

*More Details:*

The switches on the radio transmitter are not currently used— only the sticks and dials send information to the drone. Stick controls are standard US drone controls. The left dial is a kill switch and the right dial determines flight mode. The threshold for killswitch activation is about 30% between counter-clockwise and fully clockwise. It is recommended to fully rotate the dial whenever the killswitch is needed (rather than under-rotating) as the killswitch dial is only used for the killswitch.

For more information, contact *Isaiah Bugayong Cabugos , Aneri Hiren Desai , Derek Tran , Jasera Abdurrashid , Rohankumar Barouliya .*

## Documentation

No forms exist which are required for our procedure. However, all recorded data and logs are

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stored automatically when test procedures are run; During training, the docker directory has multiple logs which visualize and monitor the output of a trained model: *trajectory\_debug.png* and *results.txt*. During testing, logs are output to the console.

## References

Coex Clover Usage Guide:

<https://clover.coex.tech/en/>

FAA Regulations:

<https://www.faa.gov/uas>

PX4:

<https://px4.io/>

Legacy Code:

<https://github.com/garyz712/DRLPIDDroneControl>

Current Code:

<https://github.com/isaiahcabugos/MECPS-Quadrotor-Drone-Race>

Approval and Revision History:

Approver:	Date Started (MM/DD/YY):	Changes Made:
Isaiah Cabugos	11/21/25	V 1.0 Finalized